



What steps does ASTWG recommend for advancing America's spaceport industry?

1. *Establish a national investment priority for developing a global spaceport infrastructure network.*



An integrated network of spaceports is needed for reliable and robust operation of a next-generation space transportation system in which spaceports, spacelines, space traffic control, and payload customers coordinate operations to ensure safety, promote commerce, and execute civil and military missions. Currently, there are no mechanisms in place to support the growth of spaceports on a national basis. As a result, a fragmented spaceport industry is emerging that in many cases pits private and regional interests against those of the federal government. Strategically planned spaceport infrastructure investment is needed to coordinate development of the network, lower the entry barriers for new spaceports and spacelines, establish a plan for implementing a space and air traffic management system, and standardize ground-to-flight interfaces to spur competition among the various stakeholders in space transportation.

ASTWG recommends formulating a concept of operations that provides the vision and path for developing this next generation of space transportation infrastructure. The concept should accommodate transportation to and from space, point-to-point travel on Earth, and travel between space station orbital facilities. The concept should provide for an independent, government-operated safety and coordination function for space traffic control; standardization requirements that will foster industrial growth through free-market competition; communication and data exchange protocols; licensing and certification; payload and vehicle selection; environmental protection; international

operations; abort, emergency, and contingency operations; and other essential aspects of a global space transportation system open to all suppliers and consumers.

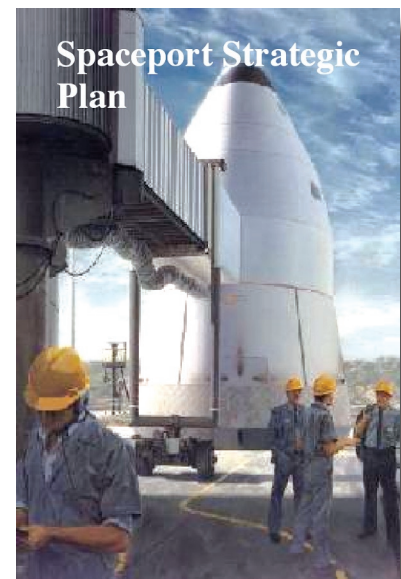
This investment in spaceport infrastructure is essential to maintain the United States' global leadership in space. Significant investment is needed to modernize existing launch site infrastructure to support current launch rates, while strategic investment is needed to guide compatible development of new spaceports. ASTWG recommends that the United States government reinvest in current spaceports and begin investing in new spaceports. Development of the space transportation enterprise rests in seed funding from the government, just as viability of air transportation relied on government investment from years past. The United States government has invested well over \$166 billion in airports over the last century and continues to fund airport projects annually. However, spaceport development has seen only a fraction of that investment, though space is the logical evolution in transportation. Capital flow into ground operations and launch infrastructure is an appropriate role for the federal government as with any transportation infrastructure.

2. Formulate a national technology program for spaceports and ranges.

The space transportation systems of today were designed to meet performance requirements rather than operability needs. This approach does not allow for low-cost, efficient access to space with operations cost constituting approximately 45 percent of the total mission cost. Advanced ground operations techniques and launch technologies are needed to reduce costs associated with processing a spaceflight vehicle and payload. The nation needs a long-term strategy for infusing new technologies into existing and future ground operations infrastructure and spaceport systems.

ASTWG recommends formulating a national technology program that will develop a national strategic plan and investment strategy to identify near-term technology projects and demonstrations that directly address some of the challenges of the far-term vision. This national technology program would encompass multiple government agencies in partnership, identifying the common needs among the agencies toward this overall vision. Such a technology program must address the entire spectrum of technology development from basic research to the capture of ideas to prototype engineering for technology demonstration, a process that advances technology readiness for full implementation into an operational system.

The strategic plan will include technology roadmaps identifying the path toward overall system development. These roadmaps will be updated annually or when new ideas and technologies come forth. An essential task of this program is to identify the technologies promising the greatest return on investment to spaceports and develop those technologies first, given the limited budget available. Return-on-investment measures may include safety improvements,



reductions in turnaround time, and efficiencies in cost. Another measure to evaluate a technology's priority is its cross-cutting nature. For example, a particular technology that can be applied to multiple fields will realize savings in technology development costs. These spaceport technologies will be prioritized based on their importance to the overall objectives of low-cost, routine, reliable access to space.



3. Develop and advocate standards for ground operations and launch systems and infrastructure.

Today's space transportation systems rely on vehicle-unique interfaces and infrastructure, driving up operations and maintenance costs. For example, there are over 400 unique interfaces on the Space Shuttle Orbiter. When an Orbiter is refurbished, each of these unique interfaces must be checked out with specialized equipment by highly skilled technicians before it can be launched again. Conversely, interfaces for airplanes and container ships are standardized throughout the fleets, supporting fast turnaround, lower support costs, and greater fleet utilization.

In aviation, different manufacturers build the Boeing 777 and Airbus A330, yet they have standard systems. Both planes use fly-by-wire technology, composites, glass cockpits, and many standard interfaces. When a Boeing 777 is at the gate, an air-conditioning hose, lavatory hose, and electrical power cable can all be hooked up to it. When it leaves and an A330 comes to take its place, all these utilities can be used on the Airbus without any change. In fact, these utilities can also be used on other aircraft as well, like a narrow-bodied B737 or even a regional jet. The same is true with the jet bridge, which can be used for any type of airplane.

ASTWG recommends that spaceport developers work together to develop a robust system that is capable of handling a multitude of vehicles. If the vehicles of tomorrow have hundreds or even scores of unique interfaces, they will see flight rates as low as the Space Shuttle sees today. At the same time, spaceports cannot demand that there be only one or two interfaces since technology drives that number. In the beginning of new spaceports, substantially more interfaces will be needed, but in the following years as technology develops, this number will be dramatically reduced.

By working together, spaceport operators, vehicle operators, and vehicle manufacturers will drive each other's development. Vehicle manufacturers are expected to drive the development of spaceport infrastructure just as they have done with airport infrastructure. For example, when Airbus announced it would build a super jumbo jet, airport operators knew they had to widen runways and taxiways to accept this new aircraft. At the same time, Airbus knew it could only make this plane so heavy or airports would ban it. By working together, Airbus and airport operators ensured

the A380 will have a home when it flies in 2006. Spaceports can serve as a home for new vehicles as long as standardization is the objective. A vehicle that does not go along with standardization or one that is too forward-thinking all at once will have trouble flying into a spaceport.

In addition to the aging-infrastructure issues, today's space access systems do not employ standard systems that allow different spaceports and ranges to operate together seamlessly. For example, the Western Range does not have the same processes and infrastructure as the Eastern Range. This poses challenges when the overall vision is to move toward interoperable spaceports. Today's isolated launch sites and vehicle-unique infrastructure must give way to a new generation of interoperable spaceports and launchers to fulfill the potential of the space enterprise.

Development and implementation of standardization is vital to the success of the space transportation enterprise. ASTWG recommends that the nation employ standardization techniques, where appropriate, when modifying existing spaceports or building new spaceports. Standardization is a major tool to reduce cost when implementing all types of space missions. Spaceport developers must explore lessons learned from the aviation industry, such as the National Airspace System that standardizes air traffic control no matter where in the United States one flies.

It must be kept in mind, however, that standards are not always the panacea for routine access to space. When viewed from the perspective of a specific mission application, the areas for standardization should be tailored to match the genuine requirements of a particular profile and the circumstances of the space mission application.

4. Generate customer-friendly space transportation policies and regulations.

Future space markets will drive the evolution of the space transportation system; however, an element critical to sustaining and nurturing the growth of space markets remains to be addressed. Carefully crafted policy and regulations can invigorate space enterprise. Unlike the immense regulation of the aviation industry today, regulation of the space industry is more situational than comprehensive. The government dictates the number of launches because the primary customer is the military, and licensing is particularly regulated by commercial customers, especially those launching communications satellites.

Federal aviation regulations have developed over time to help make the United States' aviation system one of the safest and most sought-after models in the world, but no such comprehensive regulations are in place to foster robust space commerce. ASTWG recommends the establishment of firm policies and regulations that promote smooth, efficient spaceport operation and guarantee that America's space enterprise is as safe as or safer than aviation.



Today when an airline wants to fly from one point to another, the FAA has already certified that aircraft for multiple uses, and the paperwork to conduct that flight is as simple as filing a flight plan with air traffic control. Conversely, when an operator wants to launch a space vehicle, that unique vehicle must be certified for each separate launch. ASTWG recommends that vehicle manufacturers work with the FAA to develop the certification process for space vehicles that will allow a customer to choose a vehicle, file a flight plan, and go, benefiting not only from the vehicle and infrastructure standards that cut costs and ensure safety but from streamlined regulation processes that can be just as important to getting off the ground.

Just as learning from our mistakes helps us avoid duplicating them, learning from our successes can help us replicate them. Tight regulation of telecommunications and aviation helped those industries develop and standardize – an airplane can fly into any airport, and one telephone can call any other telephone. Accordingly, ASTWG recommends strictly regulating space transportation in the early stages to help develop the industry in its adolescence. As the industry matures, the following additional steps should be considered:

- **Separate vehicle manufacturers from spaceport and vehicle operators** to prevent conflicts of interest and promote improvements in productivity and performance through free-market competition. As an example, Boeing originally operated its own airline, but as aviation matured, the U.S. government broke up this and other oligopolies, declaring that aircraft manufacturers could not also operate airlines. Boeing focused on its core competency as an aircraft manufacturer, while its operations component became United Airlines. Of course, this division did not sever all ties between the two entities. For a long time, United continued to purchase aircraft exclusively from Boeing, and eventually the expanding capabilities of a strengthened aviation industry provided greater competition and a broader market.
- **Deregulate the space industry once it can sustain itself** to create a diversified, competitive marketplace largely governed by free-market principles. Just as aviation has continued to abide by federal regulations, so will space, but competition will create equal and new opportunities for everyone.



5. Educate the public and future explorers about the benefits of space exploration and utilization.

Educating the citizens of the United States is paramount to the success of a global spaceport infrastructure network. For spaceports to flourish, each new generation needs to be educated about space and how it can directly benefit them. Making people aware of market opportunities enabled through such a medium is essential to the development of the thriving spaceport enterprise. Developing and sustaining an educated and competent workforce is crucial for the spaceport enterprise to succeed.

ASTWG recommends focusing citizen education efforts in four areas: K-12 education, postsecondary education, higher education (colleges and universities), and informal education.

The K-12 learning environment is the key to a sustained, long-term interest in space. The importance of science and mathematics is immeasurable to the development of young minds and must be emphasized throughout the K-12 career. Areas of concentration should include educator support, where classroom educators serve as the primary method to deliver ASTWG concepts, and student opportunities, where inquiry-based, project-based, and hands-on instruction are the optimum teaching strategies.

Postsecondary education is a critical point where students must receive information about advanced spaceport technologies. Students seeking to pursue aerospace careers must be introduced to emerging technologies to enable the development of necessary skills and a near-term workforce. ASTWG can serve as a facilitator for postsecondary institutions to engage in spaceport maturity, developing spaceport-specific courses in major fields of study. By offering scholarships, internships, and educational outreach projects to students in higher education, the spaceport industry (NASA and private companies) and students can benefit from practical experience in the fields of engineering and aerospace.

ASTWG also recommends that continuing education opportunities for current aerospace employees and the general public be expanded and sustained. These education opportunities vary in formality and purpose. Lectures, courses, and conferences can keep the knowledge of a wide range of aerospace employees fresh, and news coverage, exhibits, and engaging documentaries can raise the general public's awareness of advanced spaceports and their value.

By educating each of these groups, citizens of the United States will understand the benefits of the space transportation enterprise and be able to contribute to its success in the future.